

Sustainable transportation in a developing country-- The impact of the metro in Tianjin

Jian Ming Zhang

A Thesis  
in  
The Department  
of  
Geography

Presented in Partial Fulfillment of the Requirements  
for the Degree of Master of Art in Public Policy and Public Administration

(Geography Option)

at

Concordia University  
Montreal, Quebec, Canada

March 2006

© Jian Ming Zhang, 2006



Library and  
Archives Canada

Bibliothèque et  
Archives Canada

Published Heritage  
Branch

Direction du  
Patrimoine de l'édition

395 Wellington Street  
Ottawa ON K1A 0N4  
Canada

395, rue Wellington  
Ottawa ON K1A 0N4  
Canada

*Your file* *Votre référence*

*ISBN: 978-0-494-20704-8*

*Our file* *Notre référence*

*ISBN: 978-0-494-20704-8*

#### NOTICE:

The author has granted a non-exclusive license allowing Library and Archives Canada to reproduce, publish, archive, preserve, conserve, communicate to the public by telecommunication or on the Internet, loan, distribute and sell theses worldwide, for commercial or non-commercial purposes, in microform, paper, electronic and/or any other formats.

The author retains copyright ownership and moral rights in this thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without the author's permission.

#### AVIS:

L'auteur a accordé une licence non exclusive permettant à la Bibliothèque et Archives Canada de reproduire, publier, archiver, sauvegarder, conserver, transmettre au public par télécommunication ou par l'Internet, prêter, distribuer et vendre des thèses partout dans le monde, à des fins commerciales ou autres, sur support microforme, papier, électronique et/ou autres formats.

L'auteur conserve la propriété du droit d'auteur et des droits moraux qui protègent cette thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation.

---

In compliance with the Canadian Privacy Act some supporting forms may have been removed from this thesis.

Conformément à la loi canadienne sur la protection de la vie privée, quelques formulaires secondaires ont été enlevés de cette thèse.

While these forms may be included in the document page count, their removal does not represent any loss of content from the thesis.

Bien que ces formulaires aient inclus dans la pagination, il n'y aura aucun contenu manquant.

  
**Canada**

## ABSTRACT

Sustainable transportation in a developing country-- The impact of the metro in Tianjin

Jian Ming Zhang

This thesis delves into the choice of sustainable transportation means and various factors that come into play. For such a developing country as China, it is of vital significance to boost its social and economical advance in a healthy and harmonious manner when it comes to providing guidance for the public to adopt transport modes of sustainability.

With a high popularity of bikes and newly developed metro system, the city of Tianjin presents itself as an ideal example for the study of sustainable transport means. I chose this city for questionnaire surveys in hopes of not only identifying the principal factors that have an effect on people's choice of transportation modes, but more importantly offering significant references for the government in making transportation policies.

## **Acknowledgements**

I thank Concordia University for give me a real education for real world, particularly the faculty and staff of Geography Department for continued support .Many thank to my advisor John Zacharias, the kindly wisdom of Dr. Alan Nash , the reassurance of Annie Pollack, they encourage me to still working in my research, and finish this thesis. A special thanks to Mr. Chen Tian and Mr. Chen Zhi, without their helping, this thesis would still be a work in progress. My Deepest Appreciation and gratitude to my parents and my son Jingbo, who continually offer such tremendous unconditional love coupled with truly sustainable growth and support. Think you for your love!

## Table of Contents

List of Figures.....	vii
List of Table.....	viii
Perface.....	1
Chapter 1 Introduction.....	3
1.1 Urbanization in China.....	4
1.2 China's faste economic growth.....	4
1.3 Traffic problems.....	5
1.4 Background of Tianjin.....	6
Chapter 2 Literature review .....	7
2.1 Conceptual Framework.....	7
2.2 Concept expansion.....	7
2.2.1 Sustainability and sustainable transportation.....	7
2.2.2 The non-motorized mode.....	10
2.2.3 The public transportation.....	17
2.2.4 Factor that may affect the sustainable:economics,distance,income, and travel time.....	18
Chapter 3 Methodologies.....	25
3.1 Introduction.....	25
3.2 What means are utilized in this research?.....	25
3.3 What should we do this kind of survey?.....	26
3.4 Why choose Tianjin for our case study?.....	26
3.5 The selection of survey location?.....	27
3.6 Type of interviewees:city residents in Tianjin only.....	27
3.7 Fundamentals of the projecting metro line.....	28
3.8 Research Methodology.....	29
3.9 The travell time.....	30
Chapter 4 Methodology of analysis and discussion.....	34
4.1 Introduction.....	34
4.2 How many people used the dufferent transport mode in these surveys?.....	34
4.3 How many individuals were interviewed in four diferent place?.....	35

4.4 How many members were there in a family?.....	36
4.5 How many bicycles were there in a family?.....	37
4.6 How many individuals owned the car?.....	38
4.7 What was the relationship between the income and transportation mode?.....	38
4.8 Upon the completion of metro will how many people save time..	40
4.9 Interviewees'occupations.....	44
4.10 Will the proposed metro save time?How many interviewees,from one place to another,said yes?.....	45
4.11 Important conclusion drawn from interviews.....	47
Chapter 5 Conclusion.....	56
Bibliography.....	62
Appendix A.....	69
Appendix B.....	70
Appendix C.....	71
Appendix D.....	72
Appendix E: Map of Tianjin Metro system and interviewee's Home location.....	73
Appendix F: Questionnaire.....	74

## List of Figures

Fig 4.1	Bicycle in a family.....	37
Fig 4.2	Compare time save by mode.....	41
Fig 4.3	Save time data and diferent mode.....	42
Fig 4.4	Save time data and mode.....	42
Fig 4.5	The total time saved.....	43
Fig 4.6	Interviewee's occupations.....	44
Fig 4.7	Interviewees' occupations percentage.....	45
Fig 4.8	Different place and save time people.....	46
Fig 4.9	Compare with the metro finish before and after,the people use the diferent modes.....	52

## List of Table

Table 3.1	The bicycle speed resrarch.....	29
Table 3.2	The bus speed research.....	30
Table 4.1	Modal choice of Tianjin residence.....	35
Table 4.2	Interviewed in four location.....	35
Table 4.3	Household size of Tianjin residence.....	36
Table 4.4	Bicycles in a family.....	37
Table 4.5	Individuals owned the car.....	38
Table 4.6	Income and transportation mode.....	39
Table 4.7	Save time and non-save time people.....	40
Table 4.8	Time save by mode.....	40
Table 4.9	Save time data and different mode.....	41
Table 4.10	Interviewee's occupations.....	44
Table 4.11	Different place and save time people.....	46
Table 4.12	Number of time-saving individuals using various transport modes.....	48
Table 4.13	Time, income, place, bike, job, motorcycle, car, hosehold, Distance as factors in mode choice.....	49
Table 4.14	Use multiple regression, get different factor signification Number.....	50
Table 4.15	Different transport mode in all city people trips.....	51
Table 5.1	Projected time saving using this research results and Tianjin offical data.....	59



## Preface

This study arose out of my personal interest in sustainable transportation, especially bicycles and the metro-bus combinations. So far as developing countries go, sustainable transportation is an interesting and important topic. I was born and so far have spent a substantial part of my life in Tianjin, a cosmopolitan city in North China. I remember clearly some experiences in my hometown, including how I rode a bicycle from one end of the city to the other. With the rapid economic growth, the city has witnessed tremendous transition with respect of its transport system. Nevertheless, like other big cities in developing countries, Tianjin also faces a multitude of transport-related problems that need serious tackling. Thankfully, the municipal government has made every effort to improve the city's public transportation system and infrastructure, such as the construction of metro. It merits attention that Tianjin boasts, among all cities, the nation's biggest population of bike riders.

This has provided an excellent sample and practical scenario for my case study. My family used to live in downtown Tianjin. There were always at least 3 bicycles in my family. We relied on bicycle so often that it became part of our daily life. In winter, when the low temperature was too intolerable for us to continue riding our bikes, we used the city's public transport system, such as bus or metro. Since the winter 2002, I have been living in Montreal as an immigrant. Being in contact with this dynamic city allowed me great opportunities to experience the high quality public transport system. This enables me to associate the transit mechanism here with that of my hometown. Is Tianjin capable of establishing its own advanced public transport system in the future? What mode of transportation will best suit my city on its way toward sustainability?

This is exactly where my intense curiosity lies and what motivates me to conduct the research regarding these topics. It is my sincere wish that such meaningful studies, irrespective of their depth and breath, would somewhat contribute to the establishment of a sustainable transport mode not only in my hometown but in all cities in developing countries.

So far as I am concerned, the experience of doing this wonderful research itself is far and away self-satisfaction and self-fulfillment. The reason is simply I love my hometown and I know this city inside out-- the exact location of each metro station, the mindset of its folks, its familiar dialect and more. On top of that, my knowledge of the Chinese language and culture does benefit me enormously when it comes to the first-hand information and data concerning my research.

Despite all the advantages, research aimed at exploring a sustainable transport mode is by no means easy because it involves various intricate factors tied to individual choice of transport means. This is particularly true to circumstances in the third world nations where speedy economic growth calls for the improvement of the transport network. Unfortunately, the huge population and underdeveloped social and economic level normally would impede a smooth transition from a traditional transport mode to a sustainable one. Therefore, this thesis delves into the emerging issues and conflicts developing nations are facing en route to sustainability. The identification of a transport mode that may represent the merits of transport means would be of immense value for the city planners not only in my hometown but in other developing cities, to make feasible policies in favor of its early establishment.

## Chapter 1 Introduction

Today, more than ever before, many a city in developing nations faces serious transport-related problems, including chronic urban congestion, inadequate transit, diminished bicycle paths and neglected pedestrians, let alone the escalating air pollution (Zhan et al, 2005). All these disturbing issues have been caused by a substantial rise in the traffic demand triggered by fast economic growth and urbanization, mismanagement of vehicle emissions, as well as a dearth of proper infrastructure. Traditional belief regards the construction of new infrastructure as an effective panacea. However, the reality in developing nations shows that just doing this would be far from sufficient to meet the challenge and thus efforts should be prioritized on creating a sustainable development transport mode (Zhang, 2005).

Compared with others, metro is one of the best transport means that can meet the needs of sustainable development in public transportation (Yang et al, 2004). As a matter of fact, it is the exciting growth of metro that has attracted our attention and made us believe that this fascinating transit system might contribute to sustainability. This thesis intends to explore how the emergence of the metro system has challenged the conventional transportation mentality; to research such factors as transport means, family status, occupation, income-- essential ingredients closely tied to people's behavior in utilizing transport modes; to make reasonable evaluation, based on survey and analysis, as to whether the metro system will operate successfully upon its establishment; most importantly to provide a feasible mode of transportation that may

Well address the many problems on the road toward sustainability.

### **1.1 Urbanization in China**

It is China's stunning economic growth over the past decade that has pushed forward the process of its urbanization. According to "People's Republic of China Humanity Development Report" (People's Republic of China Humanity Development Report 2002), the urban population in mainland China stood at about 450 million in 2000, achieving a 35% urbanization level; by 2010 the urban population is projected at 630 million with a 45% urbanization level. Since the level of urbanization will to a great extent influence the way urban transportation operates, the projected statistics will provide significant guidance for the study of the transportation modes in urban China. One important interesting phenomenon we have been observing is that the transportation modes are closely associated with the size and the compactness of a city's urban area (Ford, 2003). This is particularly typical of the densely populated cities in China where the urban commuters would traditionally rely on bus and bike as their major transportation means. For instance, a big city proper usually has a radius of 6 kilometers, about half an hour bike ride; with a medium-sized city of 3-kilometer radius, the benefits of the bike mode are even more obvious. Over quite a long period, such a mode has played a key role in China's urban public transit and is still working well to certain extent.

### **1.2 China's fast economic growth**

Nevertheless, the ever-expanding cities spawned by China's fast economic growth make the existing bike mode inadequate to meet the challenges: traffic gridlock due to

phenomenally increased number of vehicles; inadequate road provision. Construction of new facilities connecting the compact urban districts and the newly developed satellite towns has never become so desperately imperative (Wu, 1995)! While improving and modernizing the existing systems and facilities is a feasible alternative, emphasis must be placed on far less space-consuming transit, such as metro and light rail. As a result, the ideal combination of surface transportation with underground rail network would enormously raise the urban traffic efficiency and provide more convenience, thus greatly contributing to enhanced urban livability of cities. In return improved urban transport conditions would sustain the economical growth in the long run.

### **1.3 Traffic problems**

A majority of mainland China's population inhabit densely the plain areas which, in contrast, cover only 1/5 of the country's vast territory (Hou et al, 2004). It is in those economically advanced regions that the pace of urbanization, which would inevitably induce many traffic problems, is faster than the rest of the nation. It is therefore of critical importance for those regions to have a reasonably arranged transportation mechanism in order to make better use of the land, raise traffic efficiency, but most importantly to maintain the urban development without sacrificing the environment (Zhang, 2002). That is why we have attached so much importance to seeking a transport mode that we believe works best toward sustainability in developing countries.

In the course of an investigation in the summer 2004, I applied over 700 questionnaires to pedestrians near Tianjian's 4 metro stations. Approximately 465 sheets received were counted as validly answered and useable. Based on a comparison of before and after conditions and

analysis I estimated how the metro, once in operation, would save the passengers time, compared with their transport mode at that moment. Having weighed all the pros and cons with regard to different transport modes, I have tentatively come to the conclusion that a multi-mode system that combines bicycle, bus and metro is so far the most feasible for sustainable development of transportation.

It is my belief that the scientific conclusions reached through these analyses will provide the government with useful information and reference to draw up efficient transportation policy in order to materialize the sustainability of the transportation modes.

#### **1.4 Background of Tianjin**

Tianjin is a beautiful city in the north of China. The distance from Tianjin to Beijing (capital of China) is about 120km. As a super large city of China, it has high-density road systems, including the three ring roads, (appendix E). Tianjin has a big transportation problem, including of Traffic jams (Appendix A); traffic conflict (Appendix B); traffic air pollution. In downtown of Tianjin, the net road density is higher than net work outside, but the auto vehicles running in downtown are slower than those in the outside, it is meaning this city need not only the bus and car but also other transportation modes (for example metro and bicycle). In 2004, the Tianjin government rebuilt the metro system---the old one was built in 1970's, was only 7km, enlarging the metro system, from 7km to 26km. It is called Line 1 of the Tianjin Metro. After that they plan to build another 4 lines of the metro. In downtown of Tianjin, there are a lot of people using the bicycle mode and walking mode. We hope after metro finish, more people use the bicycle-metro-bus combination transportation mode.

## **Chapter 2 Literature review**

### **2.1 Conceptual Framework**

To better understand different points of view with regard to the transportation modes in this chapter, a framework must be established. Sustainable development and sustainable transportation are the first and the foremost concepts; the second is the non-motorized transport mode such as the cycling mode and the walking mode. The third is the public transportation, which includes bus, metro, light train; the last but not the least are the many factors that may impact traffic modes, such as travel time, household and income.

### **2.2 Concept explanation**

#### **2.2.1 Sustainability and sustainable transportation:**

Sustainable development is a process of developing land, cities, business, communities, and so on that *"meets the needs of the present without compromising the ability of future generations to meet their own needs"* according to the Brundtland Report, a 1987 report from the United Nations (Brundtland, 1987). One of the factors which it must overcome is environmental degradation, but it must be done without forgoing the needs of economic development, social equality and justice.

A milestone of social and economic development, the concept of "Sustainable Development" was developed in 1992 at the United Nations Environment and the Development Congress convened in Rio de Janeiro, Brazil. This was fundamental for understanding the monumental "Rio Declaration" and "Agenda 21" (Report of the United

Nations conference on environment and development Rio de Janeiro, 3-14 June 1992). Since then, a good number of countries in the world have prioritized the issue of “sustainable development” at the top of their agenda by establishing special sustainable development committees and formulating their own developmental strategies.

As the phase and the level of economic development vary from country to country, one government may set their focus and objectives different from another. In such a developing country as China, implementing the strategy of sustainable development is of particular significance in that the country’s economy could likely grow at the expense of the environmental deterioration and the exhaustion of its limited energy and natural reserves (Wu et al, 1994).

Also commonly referred to Sustainable Transport or Sustainable Mobility, there is no widely accepted definition of sustainable transportation by any of these names. Since it is a sector-specific sub-set to the post-1988 sustainable development movement, it is often defined in words such as this: “Sustainable transportation is about meeting or helping meet the needs of the present without compromising the ability of future generations to meet their own needs.”

But this is only a starting point. The concept of sustainable transportation is a reaction to some of the things that have gone radically wrong with transportation policy, practice and performance over the last half of the twentieth century in particular (unsustainable resource take, energy profligacy, pollution, declining service levels despite increasing investments, poor service for specific social and economic groups). Over most of the century, it was assumed that adequate transportation structures needed to be built since they provide an essential underpinning to growth and economic health. Accordingly the main concern of transport planners and policy



makers was in the "supply" of transportation, and specifically in ensuring that the supporting infrastructure was going to be adequate to support all projected requirements. The dominant approach was, therefore, to forecast and then build to meet. In public transport planning likewise it was the supply and efficient operation of vehicles that got the build of attention. As a result, it is claimed by many analysts and observers that most places have as a results heavily overbuilt their physical transportation infrastructures, which in fact has led to unsustainable levels of traffic and resource use.

*From Wikipedia, the free encyclopedia, as per Sunday, January 29, 2006.*

(Full article at [http://en.wikipedia.org/wiki/Sustainable\\_transportation](http://en.wikipedia.org/wiki/Sustainable_transportation))

Conceptually, sustainable development constitutes not only the sustainability of the social and economic fabric, but the rational use of energy and environmental protection (Lin et al, 2002), the latter is where my interest lies as I intend to address a closely relevant issue—the sustainability of transportation modes. In the following paragraphs, attention is focused on the concept of sustainable transportation system because the development of transportation comes to be of critical importance for social and economic development. Urban planning findings point to the fact that transportation modes have a substantial bearing on the urban environment. A well-designed sustainable transportation mode enormously contributes to purifying the city air and maximizing convenience to the commuters without raising energy costs. When it comes to developing nations, however, the materialization of sustainable transportation is by no means easy because either their present social and economic level or their cultural and religious doctrines restrict their choices of transport modes (Wang et al, 1997). It has been a real challenge to combine the traditional and modern modes and to identify

their relationship as well. Many scholars has made every effort to find out how the right public policy could be applied to supporting the sustainable transport modes. None of the studies have yet to come to fruition in new transportation systems.

It is with a sense of obligation and responsibility that I am presenting in this paper some of the valuable perspectives by some experts interested in studying issues with respect to the sustainability of transportation modes in China and other developing countries. Today, more than ever before, China is in dire need of a good public policy to provide the guidance for the establishment of a sustainable transportation system, which should be an essential part of the creation of a “society in harmony” as the Chinese government advocates (Hu, 2000).

According to Chinese policy makers and experts, it does not make sense to merely blame the “squabble” between the vehicles and roads as the culprit. (He et al, 2000) in such a densely populated country as China, it is combining urban planning and transportation planning that would enable us to address the sustainability of urban transportation. Among all others, the creation of a feasible and innovative transportation mode should be given top priority thanks to its more economical construction and maintenance costs. This represents the principal points of view held by some experts in urban planning and transportation.

### **2.2.2 The non-motorized mode**

The non-motorized mode refers to the combination of non-motorized vehicles with pedestrians. The so-called NMVs – “bicycles, cycle-rickshaws, and carts or others -- play a vital role in urban transport in much of Asia. NMVs account for 25 to 80 percent of vehicle trips in many Asian cities, more than anywhere else in the world” (Replogle, 2000). It is interesting to note

that the bicycle started its career as a means for sport and recreation of the upper class in the last part of the nineteenth century (Veraart, 1990).

It's intention is to address the interesting issue of the role of the bicycle, among all other things. In China traditionally the bicycle has been the country's transportation mainstay. In addition, the lay out of road networks in residential areas often does not allow mini-buses and cars to enter (Dimitriou, 1995). An ideal vehicle for short distance trips, it is blessed with myriad advantages: flexibility, convenience and greater reliability (Zacharias, 2003). Despite its dwindling number in some of China's cosmopolitan cities where the wave of motorization hits and its unclear prospect, its use remains "a significant advantage for Chinese cities facing substantial challenges to a viable and sustainable transport future." It may never vanish from modern China's urban scene primarily because of the rising demand for environmental protection. The popularity of bicycling among the urban Chinese before the middle of 1990s could be attributed to the following factors:

#### 1) Government support & public policy

According to Dr. Matthew, the Chinese government had traditionally been an advocate of cycling. It invested to facilitate the manufacture of the country's own bicycles; subsidized commuters on a monthly base for cycling to work to relieve pressure on the overcrowded buses; allowed for ample street lanes devoted to bicycles (Matthew, 1995).

#### 2) Limited choices

Most of the remainder (people other than motorists and bicyclists) then, have to rely on walking or public transport; but public transport is unreliable and overcrowded. To board and disembark often requires a physical struggle, and being unable to get on or

off the bus is not uncommon because of the numbers of people crammed on board (Matthew, 1995). Given the frustration with the bus, people would prefer the bicycle as an alternative for the perceived freedom and comfort even though physical strength is required.

### 3) Affordability

Compared with the cost of purchasing and “feeding” a car, that of a bike is next to nothing and much more affordable for most Chinese families, some of which may own even 3 or 4 bikes (car purchase: USD5000-50,000; bike purchase: USD30-50 ). Therefore, income plays a significant role in influencing transportation choices people have. Many low-income people in Asian cities cannot afford even subsidized public transport fares and have no choice but to walk or cycle. Since a more substantial share of their income has to be spent on transportation than higher income households, the poor will continue for the foreseeable future to be dependent on non-motorized transport modes for mobility, irrespective of city size (Matthew, 1995).

### 4) Geographical and demographical factors

In urban China, population density is extremely high with 35 per cent living in cities of half a million (Replogle, 2000). Provided that car ownership for Chinese families reaches the level of the Western living standard, the whole urban transportation system will be brought to a disastrous standstill. Thus the bicycle has played an effective role in minimizing the catastrophe stemming from the traffic jam.

### 5) The popular appeal of bikes

In Shanghai, China’s largest city and economic powerhouse, the urban planning experts did research to examine the growing gap between the supply of urban transportation

facilities and the demand for travel. They found that as it would take great amounts of time and resources to transform the municipal transportation infrastructure into one that suits the high level mobility and motorization, the supply side is constrained for the short term (Shen, 1997). On the other side of the coin -- the demand side, however, there is a growing need for better transportation network and means, as revealed by the interviewed urban residents. In this case, the option for more bikes is temporarily ideal to compensate for the discrepancy between supply and demand.

How do the people in developed countries treat non-motorized transportation?

Contrary to the popular perception in most developing countries that bicycle is an obsolete means of transportation to be taken over by the automobile, it is still considered as an important and major mode of transport in developed countries, such as Japan and Europe.

People there use the bicycle primarily out of ecological and environmental concerns and for practical purposes as well. For example, now over 80 million bicycles are in Japan and per capita ownership rate is one bicycle for every 1.6 persons (Koike, 1991). One reason (for such a high popularity) is that bicycle was discovered as an alternative transport mode to automobile, which generates aggravating problems of pollution and congestion. People buy bicycles as inexpensive and convenient means of transport.

In accordance to person trip surveys conducted in a great number of Japanese cities, the major trip purposes of cyclists in urban areas in Japan are commuting to schools and workplaces, followed by shopping and business trips. Commuting trips using bicycle is divided into two types. One is the single mode in which a bicycle is used for the entire trip from home to destination such as school or workplace, the other is such a trip that a bicycle is used as an access means to and from public transport terminals like railway

stations. Generally speaking, the average bicycle trip length of the former usage pattern is longer than the latter, in which bicycle ride is only a part of commuting trips...in large urban areas, the dual mode-commuting pattern (the latter) is more frequently found (Hirota et al, 1993). Later in this section, the dual mode pattern and the multi-modal pattern will be discussed in greater detail. Despite a high level of motorization in European and Japanese cities, the lion's share of trips is still made by walking and cycling. In Japan, for instance, there are policies providing extensive bicycle paths, bicycle parking at rail stations and high fees for motor vehicle use. Denmark and the Netherlands have reversed the decline of bicycle use through similar policies (Replogle, 2000).

#### 6) Changed stances triggered by motorization

As we described above, the bicycle played a vital role in China's urban transportation; hence the country was known as 'the Kingdom of bikes'. Unfortunately, ever since the mid 90s,

China's central government has shifted its policies to favor fast motorization.

*Eager to speed up GDP growth, it defined the automotive industry as one of the economic powerhouses, in keeping with the abundant evidence from Western societies that car industry has been closely associated with rapid economic growth. Following this decision, substantial national resources were marshaled in support of highway systems within and between cities. Civic leaders often refer publicly to the bicycle as a symbol of backwardness and economic deprivation associated with the lean years of doctrinaire socialism. Planning and transport studies invariably refer to the use of bicycle as an irritant in the transport system (Zacharias, 2003).*

It is not uncommon that foreign visitors who came to China just 5 years ago would be

flabbergasted at the dramatic changes taking place in some of the cosmopolitan cities, such as Shanghai, Beijing, and Guangzhou, upon their return. They can not believe what they have seen as if those cities had undergone major surgery. As a result, boulevards have been widened to give way to drastically increased number of cars, while bicycles are being marginalized to a very low status (Hu, 2000).

While China's lighting-speed journey to affluence might astonish Westerners, the underlying philosophy is to allow successful Chinese citizens to display their success: this is part of the reward. Since the western world has large-scale car ownership, Chinese transport planners are asking, why not us (Matthew, 1995)? As a symbol of social status, fancy cars are being shown off by the freshly emerged Chinese — people who have benefited from economic reforms. Even for a 200 or 300 meter trip after dinner, some would insist on driving there rather than simply walk.

When people exuberantly show others their wealth, they will end up paying enormously for their sheer vanity, to the detriment of the environment and the health of their own and others alike.

#### 7) Warning signs from others

In some other places in Asia, motorization has brought about persistent problems. For example, the traffic jam in Bangkok, Thailand has been known to last for hours on occasion while gas emissions have reached such a suffocating limit those pedestrians have to wear masks on the street. In Taipei, Taiwan's capital, traffic density is 10 times higher than that of Los Angeles. In Jakarta, Indonesia, thousands of cycle rickshaws have been confiscated and thrown into the sea to "reduce congestion" (Matthew, 1995), causing bigger scale motorization along with air pollution.

Which way to go?

The issue of the transportation systems has been heatedly debated for many years. We have come to a crossroad. Objectively, motorization has enormously benefited the human race through its speed, efficiency and convenience. In other words, our life quality has been substantially improved to a level we could only dream of before. Yet its side effects can never be overlooked. Provided motorization is allowed to flourish in a *liaise- faire* manner, we may end up facing the long-term environmental consequences with diminishing benefits. According to Dr. Replogle (2000), as cities in Japan, the Netherlands, Germany, and several other European nations demonstrate, the modernization of urban transport does not require total motorization, but rather the appropriate integration of walking, NMV modes, and motorized transport. As in European and Japanese cities, where a major share of trips is made by walking and cycling, NMVs have an important role to play in urban transport systems throughout Asia in coming decades.

Transport investment and policy are the primary factors that influence NMV use and can have an effect on the pace and level of motorization. For example, Japan has witnessed major growth of bicycle use despite increased motorization, through policies providing extensive bicycle paths, bicycle parking at rail stations, and a high fee for motor vehicle use (Song et al, 2002).

The Japanese and European experiences merit our attention. NMVs offer no panacea to the growing problems that motorization brings about, in Netherlands end the bicycle appears to play a large role as an access mode with a share of 35 % ( Rietveld, 2000). But if the government support is withdrawn and motorized transport encouraged in its place, a developing country like China could be planting the seeds of its own trouble. An ideal solution seems to be a combination of all the advantages of both modes so that the sustainability in transportation can be Attained (Lin et al, 2002).



### **2.2.3 The public transportation:**

The major land transport system in China includes the urban rail transit system (including the metro system and light train system), the highway transport system, and the urban transport system other than rail transit. The issue of China's railways and the reform of China's railway industry, an important part of sustainable transport system, is beyond the scope of the present work (Xue et al, 2001).

#### **Status Quo**

Thus far, the metro transport system has been operating in several major cities in mainland China: Beijing, Shanghai, Guangzhou, Tianjin and Shenzhen, In addition, new metro lines are under construction in other three cities-- Nanjing, Chongqing and Wuhan. Beijing was the first Chinese city to build a metro line. Currently, 54km of metro lines are in operation throughout the city. The first metro line in Beijing was started in 1965 and it opened in 1969. The second Beijing line was completed and started trial operation in 1984 (Xue et al, 2001).

The metro was not introduced into Shanghai until 1995 when its first line was put into operation. Presently in the city, there are three metro lines totaling 65km in operation and another 81.6km lines are under construction.

For Chinese cities, however, just making public policies in favor of the bicycle mode or NMVs mode is far from sufficient. In Shanghai with a population over 15 million and Tianjin, over 10 million, the bike per se would bring about tough problems: the bicycle parking, the bicycle traffic jams, and the provision of bicycle lanes. To build the sustainable transportation system, public policy should be formulated in support of public transportation combining the metro, city light trains, bus and taxi, with the bicycle and walking (Zhou, 1991).

It is of profound importance to seek a sustainable urban transportation mode in developing countries that can not only be economically constructed but solve myriad urban transportation problems since those countries have limited budgets to invest on the money-consuming modes. In Beijing, Shanghai, and Tianjin, the metro and city light train system have been working extremely well to tackle urban traffic problems. The metro has few downsides on the urban transport system, for example, most efficient; safest; minimum impact on the cities' historic area.

#### **2.2.4 Factors that may affect the sustainable transportation: economics, distance, income and travel time.**

In terms of economic factors, the sustainable transportation is to save the energy and cost. A one way trip may be as high as the daily wage of a laborers (Kartodirdjo, 1981). For instance, the bicycle and public transit system is typical of economic transportation mode. For such a developing country as China with an annual GDP of only slightly over 1000\$ per head in 2001 (China Statistical Yearbook 2003), saving money does make great sense.

From the perspective of cost and energy saving, biking and walking should be the primary choice of the sustainable transportation mode and public transport the secondary. Other non-motorized modes such as NMVs similarly benefit the environment and save a huge sum of money.

Distance is another important factor that impacts transportation mode. Short-run and long-run distance effect the transportation mode choice of commuter trips (Noland, 1995). This can be easily explained as: the shorter the distance is, the more individuals would tend to bank on such non-motorized transport modes as walking, bicycling, etc; the longer the distance, the more they would use motorized modes, such as bus, metro,

and private car. Another field of distance is urban spatial structure: in areas with high densities where trip distances tend to be short, non-motorized alternatives often perform well (Tolley, 1997).

It is often taken for granted that rising income will lead to more costly and more motorized travel. This trend has been to an extent reflected in China today, though not universally true. According to Zacharias, however, the relationship between personal characteristics (including income) and travel behavior thus far in China is rather weak (Zacharias, 2005). Zacharias conducted a study in which some individuals were interviewed in Shanghai as revealing that there was little difference in the frequency of travel by non-motorized modes according to income. On the other hand, higher income individuals tended to travel greater distances by bicycle or by other means (Zacharias, 2001). His observation is echoed by Michael A. Replogle "It is not only the poor who use bicycles.

The rise of income does make a difference and stimulate people's appetite for motorized transport means. But when excessive motorization results in road congestion and environmental deterioration, they have to turn to environmentally more sustainable transport modes.

Last but not least, travel time is another vital factor that influences the use of sustainable transportation means simply because it is closely associated with passengers' choices in using transportation. Value of time estimates vary widely among different travel purposes (Small, 1992). When travel time is expressed in min/km, according to Mirjan E. Bouwman and Henri C. Moll, an increase in daily mobility can only be achieved through a lowered travel time per kilometer. In other words, people normally would utilize transport modes with higher speed in order to get to their destination earlier.

Nevertheless, this factor is not the sole one that counts. Other factors, such as income as described in the preceding paragraph and traffic congestion, which tends to lower the travel speed would restrict people from relying on vehicles supposed to offer higher mobility. This perspective is explicitly stated by Replogle in his *Non-motorized Vehicles in Asia*. Ironically, individuals preferring higher speed choose motorization with the intention of saving travel time. Yet increased motorization, in return, causes traffic jam and environmental issues. Consequently, change to slower transport modes could contribute to sustainable development (Bouwman et al, 2002).

#### Environmental concerns

The cities need to better environmental, social and economic conditions for the long term. The relationship between transportation and sustainability is correlated, so is that between population density and energy consumption. “Achieving environmentally sustainable transport is one of the major challenges that countries around the world, especially OECD countries, are facing. Transport is a particularly indispensable to the economic and social fabric of all countries, but has many adverse effects on health and environment. Some important transport trends, regarding pollution, congestion, noise, land-consumption, and resource use, are moving away from, rather than towards, environmental sustainability” (Report on the International Conference on Environmentally Sustainable Transport in the Asian Region 2003, Nagoya, Japan).

The effect of weather and climate on commuting is another environmental factor (Nankervis, 1999). For the bicycle choice and another transportation mode choice, it is important. But the most important point is the air pollution. A reality of ever intensified motorization would make the environmental problems worse because the Asia countries are mostly densely populated. They have no choice but to pursue the path of the sustainable transportation mode. To this effect, public policies and government support

should be harnessed to bring the unconstrained motorization under control.

Multi-modal patterns:

According to empirical experience, trips including the public transit usually can not be accomplished just by one single mode. One or more modes are required to reach the destination. Unless the metro station or bus stop is immediately next door, the first segment is often made by foot or walking. The remaining longer distance had better be covered by the main mode (bus, metro, train). According to Bouwman and Moll, there are 5 mode combinations: 'walking-bus', 'cycling-bus', 'walking-bus-train', 'walking-train' and 'cycling-train'. 'Train' sometimes can be replaced as 'metro' depending on circumstances in different cities.

Charted for comparative purposes by Bouwman and Moll, a wealth of characteristics of various transport modes are listed in terms of use of space, energy, cost, travel time (Bouwman et al , 2002). For instance, the meaningful comparison reveals that the bus-metro mode takes the least space while walking the most space. Interestingly, the amount of energy consumed through either walking or cycling is next to nothing, while the petrol car and other modes have the highest consumption. The order of the cost (the most expensive to the least expensive) is as follows: private car, metro, bus, bike and walking. Travel time (slowest-fastest) as follows: walking, bicycling, bus, metro, and car, use a combination of modes for different trips (Van et al, 2004).

The multi-modal pattern is particularly applicable to developing countries in that their overall level of social and economic development dictates the choice of transport modes. Only by means of multi-modes will the limited economic resources in those countries be optimized for sustainability. For example, the bicycle is the least expensive mode, but it is only good for short distance. The bus and metro don't cost much, yet they are

not the most ideal when it comes to short distance trip. The best alternative would be to adopt bicycle-metro-bus mode, which blend the advantages of individual modes, to ease the existing transportation problems and provide passengers with speed, convenience and efficiency. From the perspective of sustainability, not only would this mode profoundly improve the cityscape environmentally, but also benefit the passengers economically and time-wise. The bicycle is not a substitute for the public transport but a complementary and partially overlapping mode of transport. Chinese have been establishing the system of the Bicycle-metro, bus-metro, metro-light train exchange hubs, which have been very popular in Beijing and other cities (Replogle, 2000). In the Tianjin research, we will provide detailed information regarding the metro-bus-bicycle mode in Tianjin. Bicycle-railways exchange mode has long gained its popularity in Western Europe and Japan. According to Replogle, between 1975 and 1981, the number of bicycles parked around the rail station stood at 1.25 million, but by the end of the 1980, more than 2 million bicycles were used daily to access suburban railway stations in Japan (Koike, 1994).

As countries vary significantly in terms of social and economic development, there is no fixed sustainable transportation mode. What applies to one country does not necessarily apply to another. In order to optimize transportation efficiency and sustainability, transport planners should pay close attention to different travel modes by trip length, changes in the number of various vehicles and other factors.

Why will we research multiple-modes (metro plus mode)?

According to Dr. Asensio (2002), factors that may affect individuals' choice of transportation mode include time, distance, income, etc. when it comes to CBD commuters, chances are that they may rely not only on the single transportation mode,

like private car, bus, but perhaps more on the multiple transportation mode i.e. bus-metro-bike mode. Such a mode exists in European cities and Asian cities alike. The significance to research the multiple transportation modes can be primarily attributed to the following three reasons:

1. Based on the fact that the suburban residents commuting by public transport system usually need to cover much longer distance than those residing in the city proper, simply because of the initial part of their trip between home and the bus stop or railway station they have to undergo. In order to explore what roles multiple transportation mode (referred to as metro plus mode) play in Tianjin City's urban transportation, we did research by collecting data from people living in all corners of the city.

2. Known as a function of many characteristics of the trip, the length of trip time saved is a valuable indicator to evaluate the performance of different transport modes to be chosen. Two transportation modes will be compared to find out which one is more time-saving. One is the single transportation mode, another metro plus mode. A good example is the present state of the increased traffic congestion in downtown Tianjin, where depending on one single transport mode, such bus, car or bicycle, would definitely consume plenty of time. Thankfully, the construction of the metro line will significantly defuse the traffic tension since the metro line is designed to go through the major commercial area. The integration of existing transport means with the metro would save commuters a lot more time than before.

3. The commuters' transportation choice is also somewhat contingent upon the travel distance (Asensio, 2002). This can be reflected through the popular use of the low cost modes---bicycle, walking and other non-motorized transport modes, particularly when it comes to short distance. Conversely, fewer individuals would rather use public transportation and private car than walk or ride bicycles when longer distance is

involved. The importance of distance looms large through the metro plus mode, by which commuters usually have to cover a relatively long distance.

### **2.3 Conclusion**

In this Framework chapter, we have come up with a series of concepts that are to some extent interrelated: Sustainable development and sustainable transportation; the non-motorized transport mode; public transportation; and factors that impact traffic modes, such as economics, income, age, travel time, etc. Throughout the study, I have focused my interests and attention on the first concept—sustainable development and sustainable transport in hopes of identifying a sustainable transportation mode that best fits the developing countries. Despite their respective advantages, either the NMV (bike, walking, rickshaw) or the public transport (bus, metro, light rail) alone has no ability to perfectly address all the problems if used as a major transportation mode.

Suppose we use multi-mode that combines bus, metro, and bikes as an ideal transport mode. The study conducted by the scholars referred to in our article we only find fragmented and incomplete. So only a systematic study on the multiple-modes, measured by travel time and economic factors, can you obtain useful data in support of the development of sustainable transportation. This will be of critical importance for such a developing country as China. In other words, this will provide the government with guidance in drawing upon informed policies in support of sustainability in order to redress the issues that plague the developing countries.



## Chapter 3 Methodologies

### 3.1 Introduction:

This thesis provides full description with respect to all the methodology utilized to gather and distill information and opinions from 465 survey sheets. The primary objective of this thesis is to explore the relationship between bicycle mode and public transportation; and second level is the use value of the new metro line, and calculate how to connect from the bicycle mode to the metro-bus mode.

Why do this research?

First, based upon vast amounts of meaningful evidence and data our study has presented informative evaluations as to how enormous amount of time the metro system has saved ever since it was put into operation. The study also shows how commuters' level of income should have an effect on their behaviors in the use of metro.

Second, the impact of such factors as age, income, social status on the choice of three transportation modes-- the bicycle-only mode, walking -bus- taxi / car mode, bicycle-metro-bus mode, has also been discussed.

Third, our study is committed to seeking ways to solve the touchy issues in transportation that has been plaguing developing countries. In other words, it is to those countries' greatest benefits to adopt the best sustainable transportation mode so as to draw up practical public policies.

### 3.2 What means are utilized in this research?

As one of the most effective research tools, questionnaire survey has been our principal means to consult public opinions on a spectrum of issues related to their daily behavior in using

transportation.

### **3.3 Why should we do this kind of survey?**

The follow-up seemed to be relatively easy – extracting the useful information from feedback and reaching a significant conclusion.

Because it is almost unlikely to have a complete picture about the popular attitudes toward various transportation modes simply by relying on government resources, an on-the-spot survey seems to be the most effective means to obtain the first-hand information. Since our questionnaire forms are thoughtfully designed, an objective and accurate feedback is expected and thus an informed conclusion reached.

### **3.4 Why choose Tianjin for our case study?**

We selected Tianjin for particular reasons. First, this city, with a population of over 10 million, has all that cosmopolitan cities in most developing nations have as characteristic, thus offering an ideal model for case study. Second, Tianjin does live up to China's fame as "the Kingdom of Bikes", in that 52% of this city's trips are accomplished by millions of bicycles, more than any other major cities including Beijing Shanghai and Guangzhou in the country.(Tianjin statistic year book,2002) . This should be thankfully attributed to a compact downtown area within a 5km radius; a city of endless plains; mild climate; more importantly, less income for the majority of urban population than that in Beijing, Shanghai and Guangzhou (Song et al, 2002).

Third, it makes sense to conduct this research in a city that has its existing metro system under operation and a new line under construction. The city has every ambition to create an extensive metro network that covers almost all the major shopping streets,

recreational parks

and tourist spots. This would pose a great opportunity, as well as a challenge, for us to make meaningful comparison with regard to human transportation behavior toward metro under different circumstances.

Last but not least, the city boasts a well-balanced transportation mix combining bicycle, car, bus, taxi and metro, offering a compelling reason for the study of the combined transport mode.

Tianjin is blessed with a transportation system that comparatively suits the requirement of sustainability and hence chosen for our research to find out one or two best sustainable transportation modes.

### **3.5 The selection of survey location**

The survey location selection is a stepping stone for the smooth research. We chose four spots for our field survey on the ground that all of them are located near the metro stations to be built in the immediate future. Three of them, YING KOU DAO, HAI GUANG SI and XIA WA FANG station, are situated downtown, thus with high density of population. The fourth one is in the HE DONG district where a projected metro line will be shaped from the east to the west. They are close to either bustling shopping streets or government buildings so that it is relatively easy and fast to distribute the survey sheets and get the immediate answer. May 5 to 15, 2004, 18 Canadian students from Concordia University and 15 Chinese students from Tianjin University were dispatched at those 4 spots to distribute more than 500 questionnaires sheets, among which 465 received valid answers.

### **3.6 Type of interviewees: city residents in Tianjin only (Some invalid feedback was including flooding population).**

Questions covered the information regarding interviewees' income, job, home location, major transport mode, etc.

### **3.7 Fundamentals of the projecting metro line**

- The new metro line will cover 26.188 km (No. 1 line).
- Underground part is 13.915 km; the rest of 12.273 km is elevated.
- The budgeted expenditure: 6, 895,000,000 Yuan (833,736,396 \$USD Demographic data report dated Apr. 2, 2002 from Tianjin Municipal Government revealed: The total population of the municipality: 10,008,800. Number of families: 3,031,700.
- The total area of the entire municipality: 11919.7 square kilometers, 0.118% of the whole country.
- The GDP of the city (2002) 202,260,000,000 Yuan/year.
- GDP per capita: 20150 Yuan/year.

Our research was conducted at 4 venues covering two administrative districts in downtown Tianjin and one district close to downtown. Two of them are under jurisdiction of Heping District with the population density of 43953 people/ square km. (Tianjin statistics yearly book, 2002).

The third venue pertains to the Hexi district with the population density of 19261 people/square km. The last one pertains to the Hedong district with the population density of 16863 people/square km.

Why did we choice these four survey venues?

Both the Haiguangsi station and Yingkoudao station are commercial areas with lots of commercial and residential buildings. The Xiawafang station is in the Hexi district, also with commercial and residential facilities. The high density of activities is conducive to the research.

The last one is located at Hedong District where the planned new metro line 2 will pass it. We chose this place in view of the research in the future.

### 3.8 Research Methodology

The speed of different transport mode is very important. How can we get these speed? I conducted this test with my bicycle, conducting 6 trips and timing them, the mean speed is 216.70m/min.

**Table 3.1 The bicycle speed research (including the traffic light, and any waiting time)**

distance	time	speed
7449m	30 min	248.3m/min
4307.9m	23min	187.3m/min
3229.5m	15min	215.3m/min
1153m	5min	230.6m/min
1799m	9min	199.9m/min
Mean		216.70m/min

The metro speed with the park station time is from the metro company

Speed=872.8m/min

The bus speed is also from my field research:

**Table 3.2 The bus speed research (including any waiting time)**

distance	time	speed
5891m	21min	280.5m/min
5902m	28min	210.8m/min
9316m	31min	300.5m/min
4008m	16min	250.5m/min
2320m	8min	291.2m/min
	mean	266.7m/min

Since the buses are mixed with the traffic, it is thought they have near the same travel speed.

The taxi speed and car speed is 480m/min from the bus company.

The walking speed from my research, the speed is 66.02m/min.

### **3.9 The travel time**

According to the author, travel time of the various modes is the most importation factor, and the total time includes several time factors:

Total distance of single trip= the distance from home directly to the destination (the actual road distance). The bicycle speed in Tianjin streets (with traffic light stops and traffic jam taken into account) is 13km/hour. One way to measure the distance from home to destination is by means

of the electronic map of the city . Then we can calculate the total time consumed by the bicycle mode only.

With respect to the bicycle-metro-bus mode which involves more complex factors, we can add up the length of time of each segment of the trip to calculate the total time of this mode. In this case the total travel time involves:

1. The duration for bicycle parking, usually less than 2 minutes ( $t_{11}$ )
2. The duration of bicycle riding ( $T_1$ ): we use an electronic-map to find out the distance from home to the metro station and then calculate the time= $\text{distance}/$  average speed of bicycle

3. The metro waiting time:  $t_{12}$

The average waiting time is  $t_{12}=3\text{min}$

4. The metro travel time  $T_2$

First the speed of metro  $V_2= 26.188/0.5=52.37\text{km/hour}$

With the help of electronic-map, we can calculate the distance of the metro line from one station (next to the home location) to another (next to the destination), and then we obtain  $T_2$ .

5. The waiting time for the bus after the metro riding

$t_{21}=5\text{ min}$

6.  $T_3$ : The length of time from the metro station to the destination depends on the distance.

The usual practice lies in the fact that people usually ride bicycles from home to the first metro station. In China cyclists are not allowed to use the public transportation with the bicycle. Thus, after the destination metro station they have to rely on the bus to accomplish the rest of the trip unless the second bicycle is available.

For the final trip,  $T_3 = \text{distance}/\text{bus speed}$

7.  $T_4$ : The time from the bus stop to home  $T_4 = 3 \text{ min}$  (from Bus company).

Therefore, the total length of time of the multi-modal is:

$$T_m = T_1 + t_{11} + t_{12} + T_2 + t_{21} + T_3 + T_4$$

Our objective is to compare two lengths of time with two different transport modes:

$T$  (directly), and  $T_m$  to find out which takes longer. If the value of  $T$  (directly), is bigger than  $T_m$ , it means that the multi-modal pattern saves more time than the bicycle mode, and vice versa.

Through this research, we can find out which mode does a better job by saving more time in order to evaluate if the new metro line could attract more passengers, i.e. how many individuals would like to shift their transport mode from the bicycle one to the multi-modal pattern.

#### 7. The questionnaire survey

The questionnaire survey was conducted through person-to-person interviews on the streets near the metro stations in the summer 2004, twenty-eight students from Concordia University Urban Studies program and Tianjin University in China took in the activity. The questionnaire included the following questions to the interviewees:

1. Your occupation?
2. How many people are there in your family?
3. What is your family income?
4. Your home location?
5. How many bicycles, motorcycles or cars are there in your family?



6. Today (the day of survey), what kind of the transport mode do you utilize from home to destination and how long does it take for the trip?
7. Please make your evaluation on all the transportation modes available for the trip (car, bicycle, bus, taxi, metro) in terms of time, speed, cost, comfort, and safety.
8. What is your most frequently-used daily transport mode?
9. Please tell me why you would choose the metro mode (if you prefer).

High response reason was achieved by teaming the Tianjin University students with Concordia students. This drew a big crowd of curious passers-by, and they wanted to participate in the survey. Questions were written in Chinese in order to reflect the reality of the transport needs of the population living in Tianjin. All the feedback was expected to provide vital clues for the completion of the paper.

## **Chapter 4 Methodology of analysis and discussion**

The data collected from the questionnaire survey and interviews were treated quantitatively and qualitatively. Emphasis was on the qualitative aspects in that qualitative research deals with factors that affect the people choice of transportation modes. The descriptive data from the questionnaire survey were coded and entered into a spreadsheet. Analyses and discussions on the results from questionnaire survey.

### **4.1 Introduction:**

This chapter examines and analyses all the valid answers to the person-to-person questionnaire survey at venues close to the four major metro stations in Tianjin, China. My graphic illustration and literary analysis to the feedback covers such issues as interviewees' current transport means, family status, occupation, income-- factors that are closely tied to their behavior in selecting or using transport modes. Most importantly is individuals' perception about the perspective metro to be operative in 2006. By the end of the chapter, tentative conclusions have been drawn as to the prospect of the metro and a more suitable mode that might meet the demand for sustainability.

### **4.2. How many people used the different transport mode in these surveys?**

**Table 4.1 Modal choices of Tianjin residence (n=465)**

Mode	W	%
walking	22	4.73
bicycle	285	61.29
motor	3	0.65
car	9	1.94
taxi	17	3.66
bus	129	27.74

The table 4.1 shows that a far greater number of people frequently depended on bicycles as their major transport means. In the descending order, the number of users decreases from bicycle to bus, walking, taxi, car, finally to motorcycle. Therefore, it can be assumed that a mode that combines bicycle, metro and bus is likely to be materialized after metro is put into operation. This is exactly what our research is seeking to find out.

#### **4.3 How many individuals were interviewed in four different places?**

**Table 4.2 Interviewed in four different places.**

1	HAIGUANGSI place	122
2	XIAOBAILOU place	190
3	XIAWAFANG place	89
4	HEDONG place	64

The chart reveals that the number of interviewees

Varied from place to place. Even though in some venues it was not as satisfied as we had expected, we still had a sizeable sample in support of the research for different area of the city.

#### 4.4 How many members were there in a family?

**Table 4.3 Household size of Tianjin residence (n=465)**

Size	%
1p./family	22.1
2p./fam	7.23
3p./fam	53.15
4p./fam	14.21
5p./fam	2.1
6p./fam	0.93
7p./fam	0.28

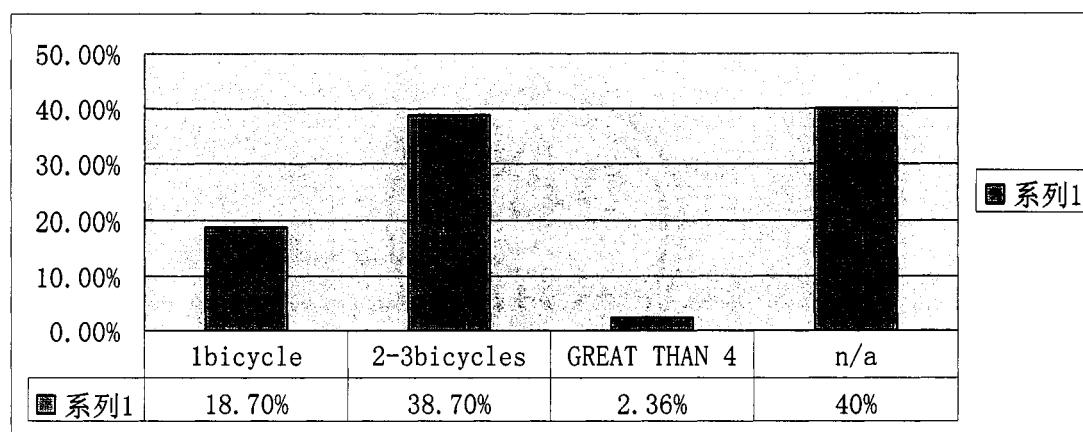
Ever since the end of 1970s, the Chinese government has implemented one-child policy in an effort to keep its huge population under control. As a result, the country has witnessed a spiral increase in the number of 3-member families over the past decades. As evidenced at Table 6, most individuals responding to our questionnaire said that they lived in 3-member families. Another interesting phenomenon is that one-member family ranked the second in number, since quite a number of students participated in the interviews. The number of multi-member families appeared to decline with the increase of the family size. Compared with the government data, the 3 people family percent is closer. This truly reflects the reality in term of the family composition in China nowadays.

#### 4.5 How many bicycles were there in a family?

**Table 4.4 Bicycles in a family**

1bicycle	2-3bicycles	Great than 4	n/a
18.70%	38.70%	2.36%	40%
87	180	11	187

**Fig. 4.1 Bicycles in a family**



This research shows that most households owned 2 to 3 bicycles, but quite a great number of households had no bicycles at all. It can be reasonably assumed that they probably relied on public transit or private cars as their principal means of transportation. About 57.4% of the families owned 1—3 bicycles. This coincides with the fact that 52% of urban trips were undertaken by bicycles in Tianjin. Then why as

many as almost 40% families in the city did not own the bicycle? The reason is that the public transportation network spreads widely, to the convenience of most urban residents. This would definitely lay a solid foundation for the future metro planning.

#### **4.6 How many individuals owned the car?**

**Table 4.5 Individuals owned the car (n=315)**

Items	Number	Percentage
car	23	7.30%
no car	292	92.70%
total	315	

China's fast-growing motorization has made increasing number of private cars stream into more families. However, purely judged from Table 9, the proportion of the interviewees who owned the car was amazingly lower than we had expected. The reason could be that most interviewees walking in the street are not assumed to own cars or/and there are not as many car owners here as in other 'richer' cities like Beijing and Shanghai.

#### **4.7 What was the relationship between the income and transportation mode?**

**Table 4.6 Income and transportation mode**

RMB/month/family

income	<1000	%	1000-3000	%	3000-5000	%	>5000	%
bicycle	43	87.76	47	53.41	89	57.42	20	57.14
walking	2	4.08	4	4.55	5	3.23	3	8.57
motorcycle	0	0.00	1	1.14	1	0.65	0	0.00
car	0	0.00	0	0.00	5	3.23	2	5.71
taxi	1	2.04	2	2.27	10	6.45	2	5.71
bus	3	6.12	34	38.64	45	29.03	8	22.86
total	49		88		155		35	

Low-income travelers apparently choose a lower speed

level to save on monetary costs (Jara Diaz and Videla, 1989).

Individual income is a very crucial factor that holds sway on people's choice of their transportation mode. For those ( the first group of individuals) with family monthly income less than 1000 RMB (\$150.00), they had no choice but to depend heavily on low cost transport mode: mostly bicycle plus some walking and bus; for those with family monthly income between 1000 -3000 RMB, their order of preferences was: bicycle, bus (increasingly more than the first group), taxi; for the third group with the family monthly income between 3000--5000 RMB and , public transit was still their cup of tea but proportionally more in this group than the previous ones favored taxi; for the group with family monthly income between 5000 to 10,000 RMB ( \$750-\$1500), they still adopted bike and public transit but began to shift their eyes on the car.

#### 4.8 Upon the completion of metro will how many people save time?

To conduct this study, we traced the path between home and reported destination .With the speed, we were able to get the time for single-mode transportation (bike, bus or walking). With the metro in place in the future and the inevitable switch of some commuters from their single mode to the metro-plus mode, we then recalculated the time. The comparison between the two modes, time-wise, would enable us to come to the conclusion as to which mode can save more time.

**Table 4.7 Save time and non-save time people**

SAVE TIME	200
NOT SAVE TIME	95
N/A	170

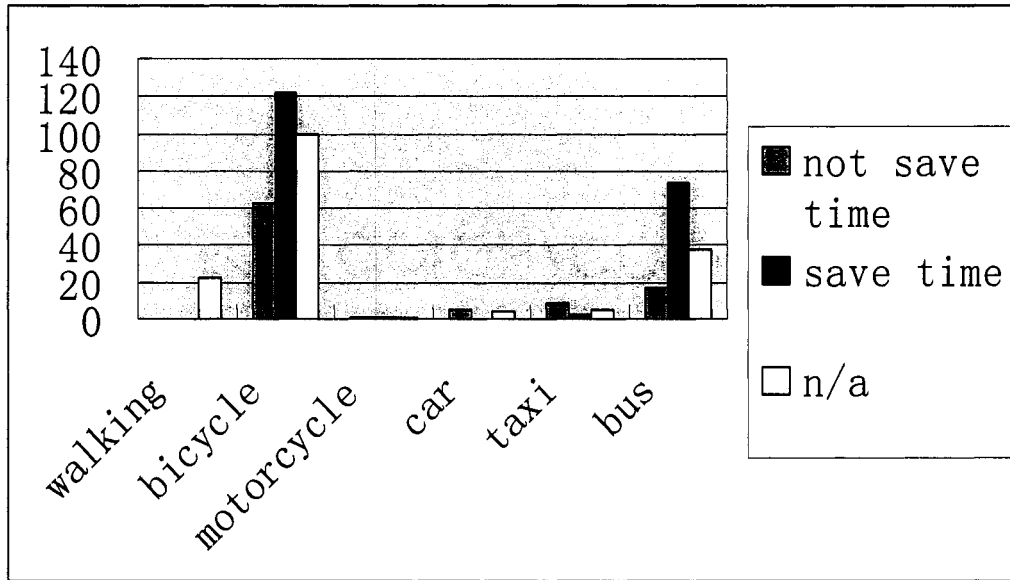
N/A is the people can not available take the metro.

**Table 4.8 Time save by mode**

	not save time	save time	n/a	% save time
walking	0	0	22	0
bicycle	63	122	100	58.82
motorcycle	1	1	1	0.59
car	5	0	4	2.35
taxi	9	3	5	2.94
bus	17	74	38	22.35
Total	95	200	170	



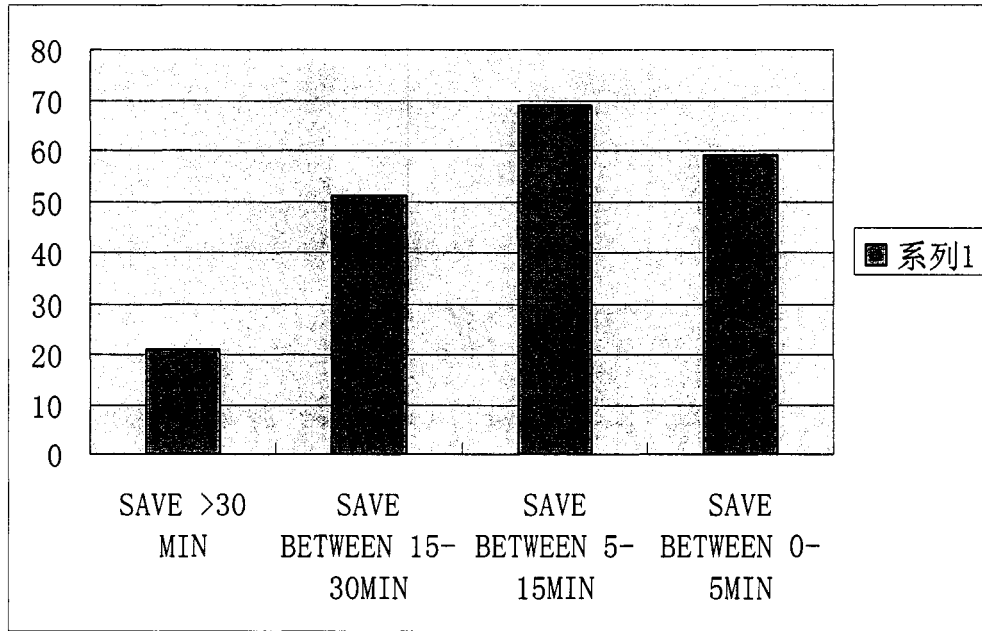
**Fig.4.2 Compare time save by mode.**



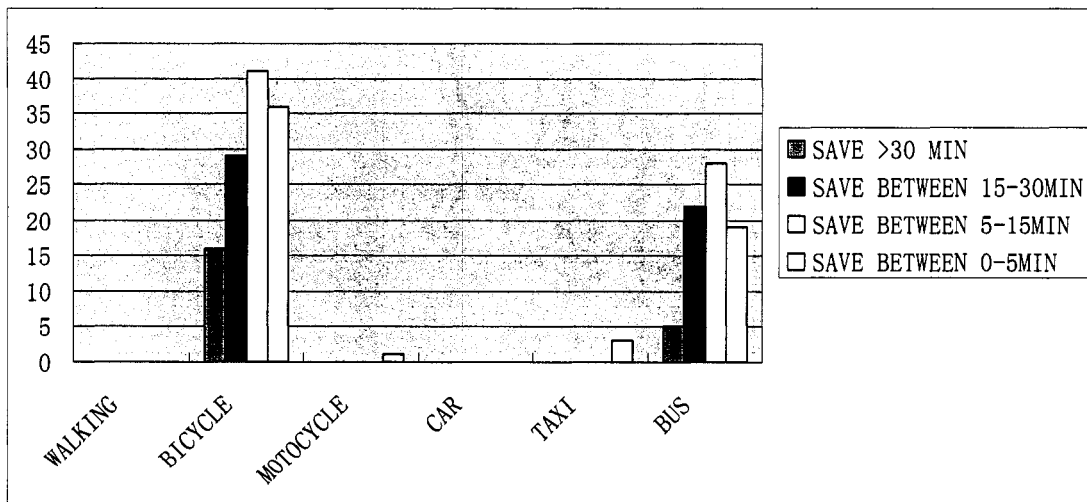
**Table 4.9 Save time data and different mode.**

ITEM	WALKIN G	BICYCL E	%	MOT 0	CA R	TAX I	BU S	%
SAVE >30 MIN	0	16	13.11	0	0	0	5	6.76
SAVE BETWEEN 15-30MIN	0	29	23.77	0	0	0	22	29.73
SAVE BETWEEN 5-15MIN	0	41	33.61	0	0	0	28	37.84
SAVE BETWEEN 0-5MIN	0	36	29.51	1	0	3	19	25.68
		122		1		3	74	

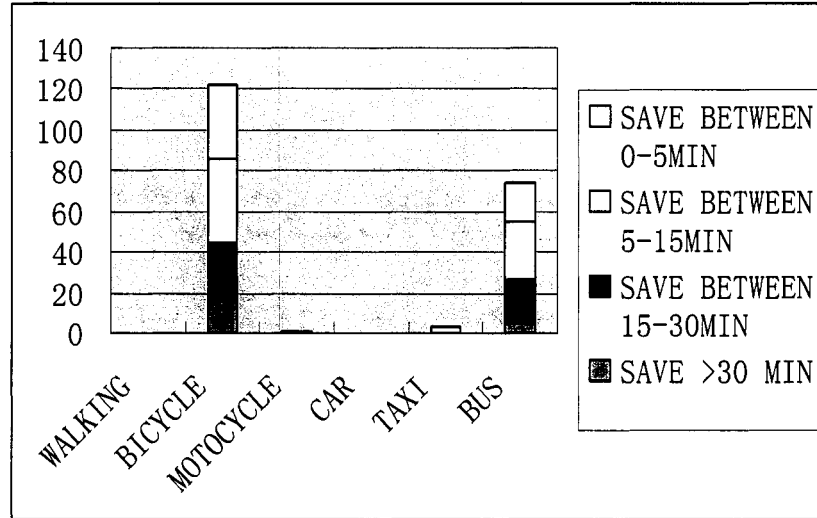
**Fig. 4.3 Save time data and different mode.**



**Fig. 4.4 Save time data and mode.**



**Fig.4.5 The total time saved.**



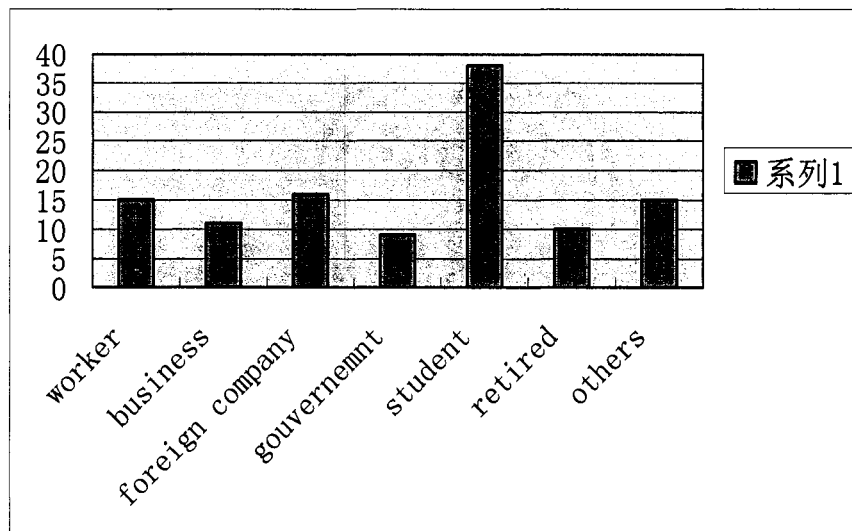
It is also consistent with the study by Littman (1999) that uses a different methodology in a different context, but which reports also that the time costs are much larger than the variable monetary costs. In the wake of the metro construction, assume the bicycle-metro-bus mode is a popular and practical transport means for general public. It may still not make a difference for those adopting walking as their major transport means because their trip usually involves a short distance. Supportive proof can be found from Table 4.5. This chart also reveals that many from both bike-riding and bus-taking groups considered the bicycle-metro--bus mode as time saving. So time wise the operation of the metro would benefit the mass passengers. For car, motorcycle and taxi users, however, the mode might not be applicable because they probably saw their transport means as fastest.

#### 4.9 Interviewees' Occupations

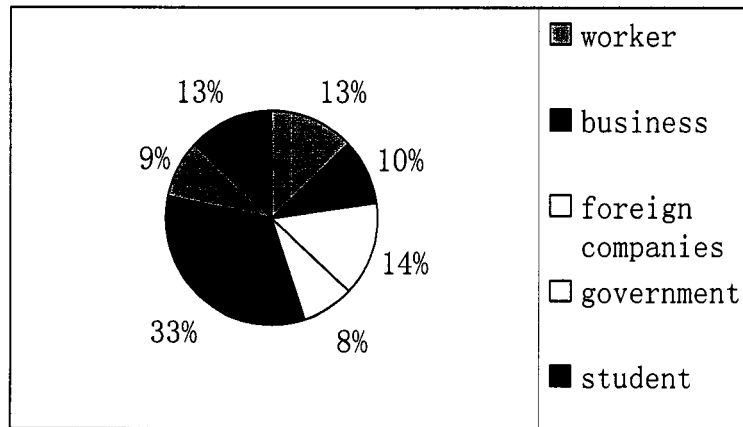
**Table 4.10** Interviewees' Occupations (n=114)

worker	business	foreign companies	government	student	retired	others
15	11	16	9	38	10	15

**Fig.4.6** Interviewees' Occupations



**Fig.4.7 Interviewees' Occupations percentage**



It is generally true that jobs involving higher skill levels are more specialized and therefore less common, implying longer commuting distances (Rouwendal and Rietveld, 1994).

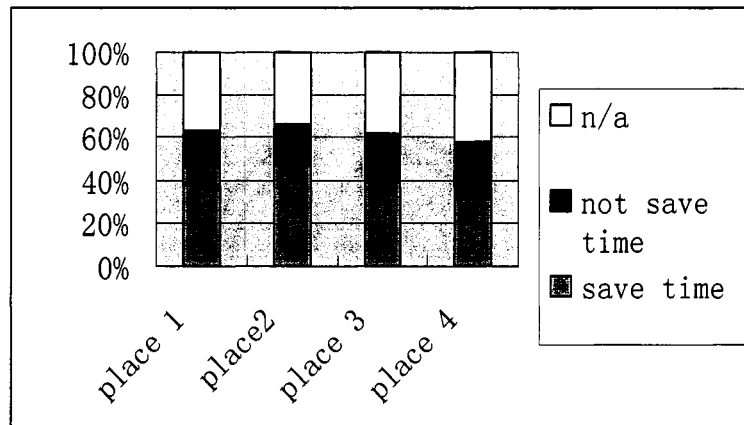
This table shows interviewees' various jobs. It serves as an exceedingly useful reference for public policy makers, particularly when it comes to pricing the metro ticket price. Obviously, the proportion of students on the chart is quite high.

4.10 Will the proposed metro save time? How many interviewees, from one place to another, said yes?

**Table 4.11 Different places and save time people.**

	save time	not save time	n/a
place 1	56	21	45
place2	89	37	64
place 3	35	20	34
place 4	20	17	27

**Fig.4.8 Different place and save time people.**



A successfully operating metro ought to provide passengers with more rapid service. In other words, metro riders would benefit by saving their time. In this regard, at least 40 of the interviewees at each of the four venues responded positively, as opposed to far fewer negative responses. This signifies that a good number, if not overwhelmingly, of people had a consensus

that the metro will save time. But there were also some N/A answers, which may indicate some individuals were not satisfied with only one metro line. They would like to have more metro lines to cover more urban areas and benefit more individuals.

#### 4.11 Important conclusions drawn from interviews

1. The operation of the metro starting in the nearest future is expected to reap a win-win harvest for both the operator and the passengers.
2. The bicycle and bus will temporarily remain most urban citizens' daily means of transportation before the metro is put into operation. Ultimately, it is the multi-mode of transportation combining bus, metro and bike that will be a more advisable choice toward sustainability.
3. The income is definitely not an insignificant factor that affects people's choice of the transport mode.
4. Discussion about the popular belief that metro will save time.

**Table 4.12 Number of time-saving individuals using various transport modes**

ITEM	WALKING	BICYCLE	MOTO	CAR	TAXI	BUS
SAVE >30 MIN	0	16	0	0	0	5
SAVE BETWEEN 15-30MIN	0	29	0	0	0	22
SAVE BETWEEN 5-15MIN	0	41	0	0	0	28
SAVE BETWEEN 0-5MIN	0	36	1	0	3	19
total		122	1		3	74

Number of timesaving individuals using various transport modes.

All our research indicates that the factor of travel time is one of the major driving forces for people to choose their travel mode. Thus far, an overwhelming majority of passengers have showed preference toward the metro-bike-bus mode since it is most efficient in managing their time. Basically, the transportation system in Tianjin will be categorized as such a system when the metro joins it in the near future. However, the projected metro lines would hardly please everybody simply because the metro-covered area can not be accessible to all the citizens in the city. Thus more metro lines ought to be constructed to meet the insufficiency.



It is also worth noting that the length of travel time is certainly an important factor when it comes to people's behavior in choosing the means of transportation. Nevertheless even those who consider themselves efficient time-wise might not always opt for the metro system, in circumstances when some other factors, such as income, employment and the distance between home and destination, may play more important roles.

At times individuals may face another alternative in the selection of transportation mode people when the use of metro plus mode could only save them a very limited time. For example, Table 4.12 shows that the percentage of the individuals who saved time by 0-5 minutes account for 29.5% of the total number of individuals as we have calculated. For this group of people, the influence of time factor is so minute that it is the other factors like income or distance that come into play. We will explore in-depth the other factors that have effect on people's choice of transportation modes.

Income:

With multiple regression modes, we got the relationship between the transportation mode and income.

**Table 4.13 Time, income, place, bike, job, motorcycle, car, household, distance as factors in mode choice (ANOVA)**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression on	20.133	9	2.237	8.451	.000(a)
	Residual	119.918	453	0.265		
	Total	140.052	462			

### Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.379(a)	.144	.127	.51451

A Predictors: (Constant), time, income, place, bike, job, motorcycle, car, household, distance

**Table 4.14 Use multiple regression, get different factor signification number.**

### Coefficients (a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.88	0.117		16.033	0
	income	0.001	0.028	0.001	0.027	0.979
	household	0.117	0.029	0.227	4	0
	Bike	-0.059	0.022	-0.135	-2.616	0.009
	Car	0.053	0.099	0.026	0.537	0.591
	motorcycle	-0.016	0.053	-0.015	-0.31	0.757
	Job	-0.017	0.01	-0.078	-1.734	0.084
	place	-0.012	0.026	-0.022	-0.486	0.627
	distance	0	0	1.308	2.633	0.009
	Time	-0.033	0.016	-1.014	-2.043	0.042

A Dependent Variable: mode

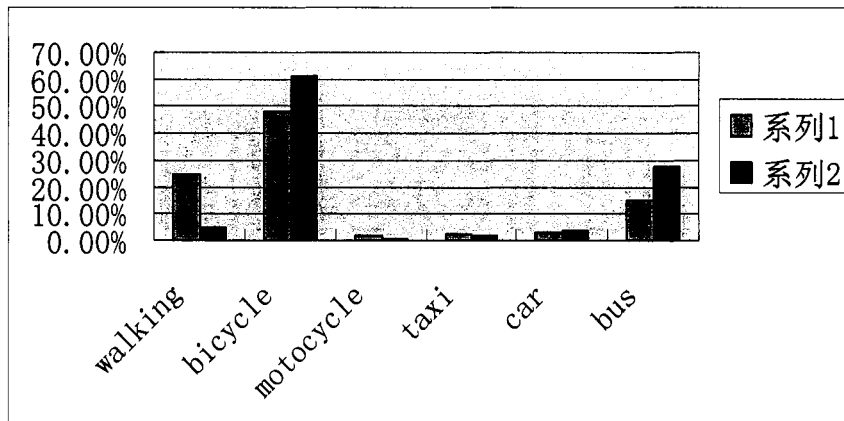
According to Table 4.14, Income Sig. is as high as 0.979, which means that the transportation mode has little to do with income. Prior to the research we had the assumption that income should hold sway on individuals' choice of transportation modes. As a rule of thumb, using transportation would cost money, with the exception of walking. The cost to buy and use bicycle in China today is also next to nothing. What really costs more or less is when it comes to the use of bus, taxi, car, and motorcycle. But our research does not bear adequate evidence to support the assumption regarding the relationship between transportation mode and income.

**Table 4.15 Different transport mode in all city people trips**

mode	official data*	research data
walking	24.70%	4.73%
bicycle	52.80%	61.29%
motorcycle	1.70%	0.65%
taxi	2.50%	1.94%
car	3.10%	3.66%
bus	15.20%	27.74%

\* From Tianjin government, 2003

**Fig. 4.9** Compare with the metro finish before and after, the people use the different modes.



To a fairly large extent, our research outcome has the proximity to the official data released from Tianjin Municipal Government in 2003, in terms of the percentage of people using different transportation modes, such as car, taxi, and motor-cycle. The exception lies in the modes of walking and bus because four sites we purposefully selected for research are in the proximity to the commercial or downtown precinct, for which people leave home generally on the non-walking model. Conversely, the data of the official surveys seem to be more comprehensive in that they covered almost every corner of the city, irrespective of commercialization. Due to restriction of time and

manpower, we were unable to obtain data so comprehensive and adequate as the government did.

In terms of monthly income, the population is classified as three groups—the low-income group with less than 1000 Yuan (approximately \$150) per person. The medium-income group with 1000-5000 Yuan (\$150-\$750) per person. The high-income group with more than 5000 Yuan (\$750). As a rule of thumb, the first group tends to adopt the bike-walking as their principal transportation mode. The second group would rather use the public transport than the bike. The third one has more buying power to purchase the car, yet some still opt for the bike-public transit mode. Our study reveals that people's behaviors in transportation use are to some extent related to their income, but it is not necessarily a decisive factor. In view of the environmental protection, the study suggests that a sustainable transportation mode surrounding the metro be utilized, even for those who have the ability to afford the use of cars.

One more question, has the use of metro anything to do with the level of income? Further study might be needed because the price of the metro ticket does psychologically affect the passengers' decision whether or not to use the metro. For the transport policy makers, it is of critical importance to reasonably price the metro ticket in order to lure more people to access this environment-friendly system. Since the majority of population is paid less than 2000 Yuan (\$300 per month, a relatively low-priced ticket is recommended. Also, a multi-purpose ticket is advisable, which means that in one direction a single ticket including the use of both the metro and the bus may be adopted to the maximize not only the ticket value but the number of public transit users.

Based on our questionnaire survey in which about 200 local students in Tianjin participated and gave their feedback, we found that a fairly large proportion of students

are willing to adopt the bike-metro-bus mode. In order to attract more students to use this mode, a half-priced metro pass is recommended, as practiced nowadays in Canada. This would not only optimize the efficiency of the metro but also more importantly demonstrate the concern from the government sector. Presently, in the absence of metro, many a student adopts the bike-bus mode. It can be reasonably inferred that they would spontaneously switch to the bike-metro-bus mode after the metro is constructed. As a result, not only the stress of the overcrowded bike parking at schools can be effectively released but the city be better positioned to manage its limited space.

Our study also finds that it is very important to plan the metro lines and stations. In other words, city planners should relocate the public transit system with the metro stations as the focus crisscrossed by other public transit lines. This would optimize all the advantages of various transportation means. For example, the establishment of a parking lot for bikes near the metro stations would effectively manage the bikes in order to minimize the loss or theft. Passengers can receive a free supervision service simply by showing their metro pass. In a nutshell, the mode blending bike, metro and bus would effectively marshal all the available resources to minimize the traffic flow and its accompanying pressure on the mainstream streets.

Therefore, a series of public policies that encourage the development of metro should be recommended, which includes but are not limited to the following:

- 1 The immediate accessibility of major shopping malls to the metro would provide enormous convenience that benefits both the shoppers and the shop owners.
- 2 The establishment of the bus stop and bike parking should be as close to the metro stations as possible in order to maximize the efficiency.

3 To provide passengers with maximum convenience, it is important to increase the number of indicators around the metro station and upgrade the illumination system inside.

4 The time interval that connects the metro and bus should be scientifically coordinated to reduce the time waste and raise the efficiency, especially when it comes to the connection between the rush hour and the shoulder hour.

## Chapter 5 Conclusion

Based on the information obtained from the questionnaire survey, a great amount of research and analysis has been made. This is of critical significance for us not only to identify the relationship between the bicycle-metro-bus transport mode and the single-transport mode (bicycle, walking, bus, taxi, car, bus), but more importantly to offer a meaningful recommendation for the future transportation mode toward sustainability. In addition, studying the relationship between people's income and their choice of transportation modes also conforms to our interests.

1. City streets in developing nations are typically packed with bikes, buses, rickshaws, taxis, cars, motorcycles and walking pedestrian's alike. Together all those elements make up the whole urban transport system. Our research has devoted generously to the issue of the bicycle since it is the most popular transport means in Tianjin, a city truly representative of the bicycle culture in China. This also stands us in good stead to delve into bicycle-related multiple-trips such as bicycle-metro-bus. When it comes to urban transport modes, the role of the bus should also under no circumstance be underestimated since it is an essential ingredient in the study of the multiple transportation modes.

2. In order to obtain different outcomes, we chose four places for the questionnaire survey. We get as many interview sheets. It is mean we will still have enough interviews came back the interview will support my research.

3. With respect to the family size, our Tianjin survey findings reveal that 53.15% of those interviewed were from 3-member families, usually composed of the parents and one child.



4. In comparison with the data of 70.30% obtained from Tianjin 2002 Statistic Year Book, this outcome is close enough since some single-parent families should have been taken into account.
5. Our research reveals that 38.7% of urban households in Tianjin owned 2-3 bicycles, among which three-member (parents and one child) families accounted for 53.15%. This could be translated as one person one bicycle for many families. In contrast, 40% of household had no bicycle at all. The number of families without bikes would continue declining with the increased public transportation, especially the operation of metro.
6. Our survey results showed car owners only 7.30% of the total. Compare with that of the developed countries, this figure was truly low. However, this apparent disadvantage could create more opportunities to develop public transportation system.
7. In addition, our research addresses the relationship between the income and the choice of transportation mode. For the low income (<1000yuan/month) families, 21.6% of their trips were accomplished by the bicycle and 14.3% by walking, because both are the lowest cost transportation modes. Unwilling to spend their money on transportation, such families had a very low usage of bus and taxi, let alone the car. For the 1000-2000rmb/month families, the order of their transportation modes was, in terms of usage, bicycle, bus, and walking. None of them owned the car. For the 2000-5000rmb/month families, the order of usage was bicycle, bus, car, and finally walking. Only 5 of them used the car, and one used the motorcycle. This group of families used taxi more than others and started to use the car. Still, the bicycle and bus remained to be the most popular transportation modes.

Even for over 5000rmb/ month families, the truly high-income group, the bicycle and bicycle still kept its lion's share among all transportation modes. Increasingly, more families out of this group rely on taxi and car as their chief transportation modes.

In summary, we believe the income is another factor that impacts people's choice of transportation modes, but certainly not the first and foremost factor. As ordinary people in Tianjin are still not very rich, the private car is not expected to get into their home for the time being. Most people still have the bicycle and bus mode as their principal transport mode.

Because the walking mode usually involves a short trip the operation of metro will not affect this mode. When the metro is put into operation, there will be bicyclists who benefit by saving their time if they use metro-plus mode.

Nevertheless, 1 or 2 metro lines can hardly cover all parts of the city to make more commuters have access to the metro in order to achieve time efficiency. Likewise, the operational metro will benefit the bus riders time-wise by providing them with the opportunity of adopting the bus-metro mode. As we mentioned in the preceding paragraph, however, more widespread metro network should be constructed to meet commuters demand. As for the motorcycle mode, which has a low sample, whether or not the metro will have effect is hard to estimate.

When the metro is used, for the car and taxi mode, the metro-plus mode can do little in time saving. Therefore, we think it necessary to keep appropriate proportion of car ownership.

**Table 5.1 Projected time savings using this research results and Tianjin official data.**

mode	official data*	save time percent
walking	24.70%	0.00%
bicycle	52.80%	61.00%
motorcycle	1.70%	0.50%
taxi	2.50%	0.00%
car	3.10%	1.50%
bus	15.20%	37.00%

\* From the Tianjin Government 2003.

The objective of our research is to come up with the data to see if people will save time by using the metro-plus, in comparison with the official data (Tianjin government, 2003).

Suppose that certain percentage of the commuters using single-mode transport would like to switch to the metro-plus mode in order to save more time. It would be that bicyclists, according to our research data, that rank the first among all the modes, followed by the bus riders. In other words, the bicyclists may have the highest probability for this changeover when the metro is fully operated. As for the modes of car and motorcycle, the users will hardly make the change. In conclusion, the operation of the metro in the future will create more individuals benefiting from the metro-plus mode in the bicyclists and bus riders.

8. The multiple regression method:

With the multiple regression method, we will be able to identify the relationship between the choice of transport modes and a few factors that may count.

Since the choice of transportation mode depends upon other factors, it is not the income but the time, the household, the bike, the job, the distance that play more important roles. The time sig. is 0.070, it is mean the time factor is good effect factor; the household is very good almost toward 0; the income factor is not significant, it is 0.727, too high; the bike factor is significant, about 0.002, as well as the job and distance, they are 0.042 and 0.019; but the car factor is not significant, it is about 0.458. Under certain circumstances whether or not you have a car is not so important, which means the income has little to do with the transportation mode. Sometimes, people with high income still have to depend on public transportation mode because other factors seem to come into play. With this method of multiple regressions, we have come to almost the same conclusion as that in the chapter Methodology and Analysis.

In conclusion, the sustainability in the city of Tianjian rests, to a large extent, in a healthy and sustainable transportation system. Without exception all the modern cosmopolitan cities in the world are integrated with an advanced and convenient web of transportation system, contributing to the urban development, the reduction of environmental contamination, the convenience to all commuters, and most importantly. This is particularly true for a city like Tianjian in a developing country to adopt an appropriate transportation system toward sustainability. A feasible and economical way to this effect is, discovered through our research, to integrate the existing transport modes into the newly developed metro system. Our research also addresses an array of factors, such as income, distance, and travel time that may affect people's behavior in their choice of transportation modes.

Last but not least, as a native of Tianjin and a researcher of transportation planning, I

would like my city, as early as possible, to present itself such an environment with truly blue sky that its people will enjoy the fruition of its sustainable transportation system.

Bibliography:

Asensio, J. (2002), Transport mode choice by commuters to Barcelona's CBD, *Urban Studies*, 39, 10, 1881-1895.

CSD NGO (2001), Input to the Secretary General's Report on Transport for Sustainable Development. Prepared by the committee of the sustainable development for the non-government organization, submitted to the Secretary General of the United Nation.

Dargay, J. and M. Hanly (2004), *Land use and mobility*, paper presented at the WCTR conference in Istanbul.

Dimitriou, H.T. (1995), *A developmental approach to urban transport planning*. Avebury, Aldershot.

Ford, F. (2003), Urbanization, Transportation and land use: policy integration toward sustainable urban energy use for cities in Asia. *Proceedings of international workshop on policy integration towards sustainable urban energy for cities in Asia 2003*. Institute for global environmental strategies all right reserved.

Gakenheimer, R. (1999), Urban mobility in the developing world. *Transportation Research Part A* 33: 671-689.

Gro Harlem B. (1987) [http://en.wikipedia.org/wiki/Brundtland\\_Report](http://en.wikipedia.org/wiki/Brundtland_Report)

He, K. and Chang C. (2000), Present and Future Pollution from Urban Transport in China. *China Environment Series*, Issue 3: 38-50.

Hirota, K.(1991), Current Issues and Problems of Bicycle Transport in Japan, *Transportation Research Record* No. 1294, pp. 40-46.

Hirota, K. and Ren, N. (1993), Bicycle, A Vital Transportation Means in Tianjin, China, *Transportation Research Record* No. 1396, pp.5-10.

Hirota, K. and Ren, N.( 1994 ), Bicycles in Japan - NMT Case Study, Proceedings of the *International Symposium on Non-Motorized Transportation*, pp.315-320, Beijing, China.

Hou, S. M., Zhu, G. P. (2004), Tianjin metro NO. 1 line, *Urban Transportation* (3):36-40.

Hu, Z. (2000), *Regional Development in China*. Beijing: Peking University Press, Beijing.

Jara D. S. and J. V. (1989), Detection of income effect in mode choice: theory and application, *Transport Research B*, 23, 6, 393-400.

Kartodirdjo,S.(1981), *The Pedicab in Yogya karta*. Gadjah Mada University Press, Yogyakarta.

Kenworthy, J.R., and Laube F.B. (1999), Patterns of automobile dependence in cities: an international overview of key physical and economic dimensions with some implications for urban policy. *Transportation Research Part A* 33: 691-723.

Lardy, N.R. (2002), *Integrating China into the Global Economy*. Brookings Institution Press, Washington DC.

Lin, S., and Song, S. (2002), Urban Economic Growth in China: Theory and Evidence. *Urban Studies*, 39, 12: 2251-2266.

Littman, T. (1999), *Transportation cost analysis: techniques, estimates and implications*, Victoria Transport Policy Institute Victoria, BC.

Matthew, S. (1995), The changing role of cycling with Chinese transport policy *Journal of World Transport*, 1, 3 1995 42-46

Mirjan E. B. ,Henri, C. M. (2002), Environmental analyses of land transportation systems in the Netherlands *Journal of Transportation Research* .part D7 331-345 Elsevier Science Ltd.

Nankervis, M.(1999), The effect of weather and climate on bicycle commuting. *Transportation Research Part A* 33 417-431.

Noland, R.B. (1995), Short-run and long-run policies for increasing bicycle



transportation for daily commuter trips. *Transport Policy*, 2,1.67-79.

*People's Republic of China Humanity Development Report (2002)*, Information Office of the State Council of China Beijing.

Replogle, M. (2000) Non-Motorized Vehicles in Asia: Lessons for Sustainable *Transport Planning and Policy Transportation Research Record*, 959.

Report of the United Nation's conference on environment and development (Rio de Janeiro 1992 )<http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm>.

Rouwendal, J. and Rietveld, P. (1994), Changes in commuting distances of Dutch households, *Urban Studies*, 31, 9, 1545-1557.

Rietveld, P. (2000), The accessibility of railway stations: the role of the bicycle in the Netherlands. *Transportation Research Part D5*, 71-75.

*Report on the International Conference on Environmentally Sustainable Transport in the Asian Region* 23-25 March, 2003, Nagoya, and Japan 24.

Small, K.A. (1992), *Urban Transportation Economics, Fundamentals of pure and applied economics*, Harwood Academic Publishers.

Shen, Q. (1997), Urban transportation in Shanghai, China: problems and planning implications *International Journal of urban and regional research*, 21, 4 589-606.

Song, S., and Zhang, K. H. (2002), Urbanization and City Size Distribution in China. *Urban Studies*, 39, 12: 2317-2327.

Tolley, R. (ed.) (1997), *The greening of urban transport* Wiley, Chichester.

*Tianjin statistic year book 2002*, the Information office of the government Tianjin.

Veraart, C.F.A. (1990), *Geschiedenis van de fiets in Nederland, 1870-1940*. Technische Universiteit, Eindhoven.

Van Exel, N.J.A. and Rietveld, P. (2004), *Travel choice-sets: determinants and implications*, Free University, Amsterdam, mimeo.

Wang, C. L.,and Shen, J., Xu Y. F. (1997), *Urban transportation capacity and traffic environment supporting capacity*. China environmental press, Beijing.

Wu, F. (1995), Urban processes in the face of China's transition to a socialist market economy. *Environment and Planning Government and Policy* 13: 159-177.

Wu, C. S.,and Liu, Y. (1994), *Urban transportation system and economic factor Beijing geography press 1994 Beijing*.

Xue, X., Schmid, F. and R A. S. (2001), An introduction to China's rail transport Part 2:

urban rail transit systems, highway transport and reform of China's railway. *Rail and rapid Transit* vol.216 part F, IM echo .

Yang, X.G., Zhang, Y. and Zhang, H. J. (2004), Analysis of Traffic Information Service in Urban Rail Transit Hubs *Urban Mass Transit* 7 ,5 pp.27-29 Shanghai Tong Ji University press Shanghai.

Zacharias, J. (2002), Integrating the bicycle in Chinese cities – the role of environment-behavior studies. *Journal of Asian Urban Studies*, 3, 3, 29-36.

Zacharias, J. (2003), The search for sustainable transportation in a developing city: the case of Tianjin. *International Development Planning Review*, 25, 3, 283-299.

Zacharias, J. (2005), Non-motorized transportation in four Shanghai Districts. Bicycle in Shanghai: movement patterns, cyclist attitudes and the impact of traffic separation 11 *International Planning Studies*, 10,3-4,323-340,

Zacharias,J. (2006), Choosing sustainability: the persistence of non-motorized transport in Chinese cities. Chap. 4 In Mira, G., Cameselle, S. and Martinez, J. (Ed). *Culture, environmental action and sustainability*. Hogrefe & Huber. 219-230 Cambridge MA USA

Zhan, K.Q., Cheng R., and He, S. J. (2005), On construction of rapid rail transit development in Tianjin *Journal of Urban rail Transit* 22—25

Zhang, X. Z. (2005), LCA and Urban Transportation choice

[http://www.iicc.ac.cn/05environmental\\_protection/t20050314\\_16779.htm](http://www.iicc.ac.cn/05environmental_protection/t20050314_16779.htm)

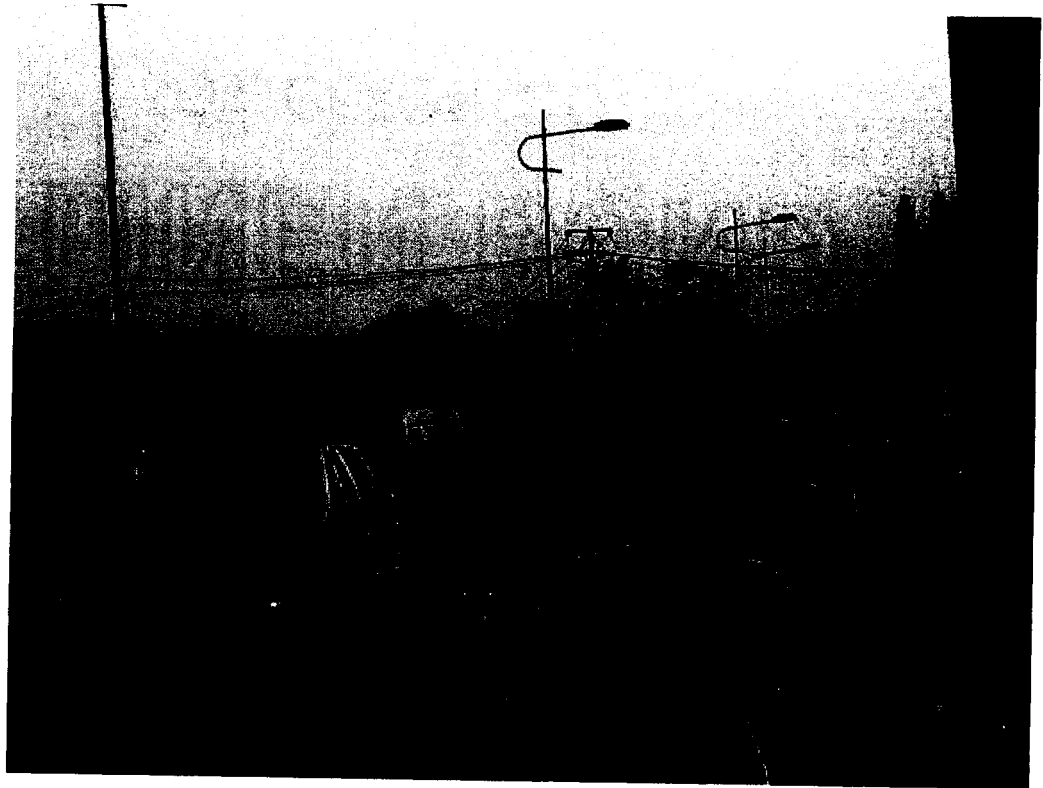
Zhang, G. Z. (1999), *Urban developing Research*. Beijing Railway Press Beijing.

Zhang, K. H. (2002), What Explains China's Rising Urbanization in the Reform Era?

*Urban Studies*, 39, 12: 2301-2315.



**Appendix A: Tianjin traffic jam. Photo taken by author June 2005**



**Appendix B: Tianjin traffic conflict Photo taken by author June 2005**

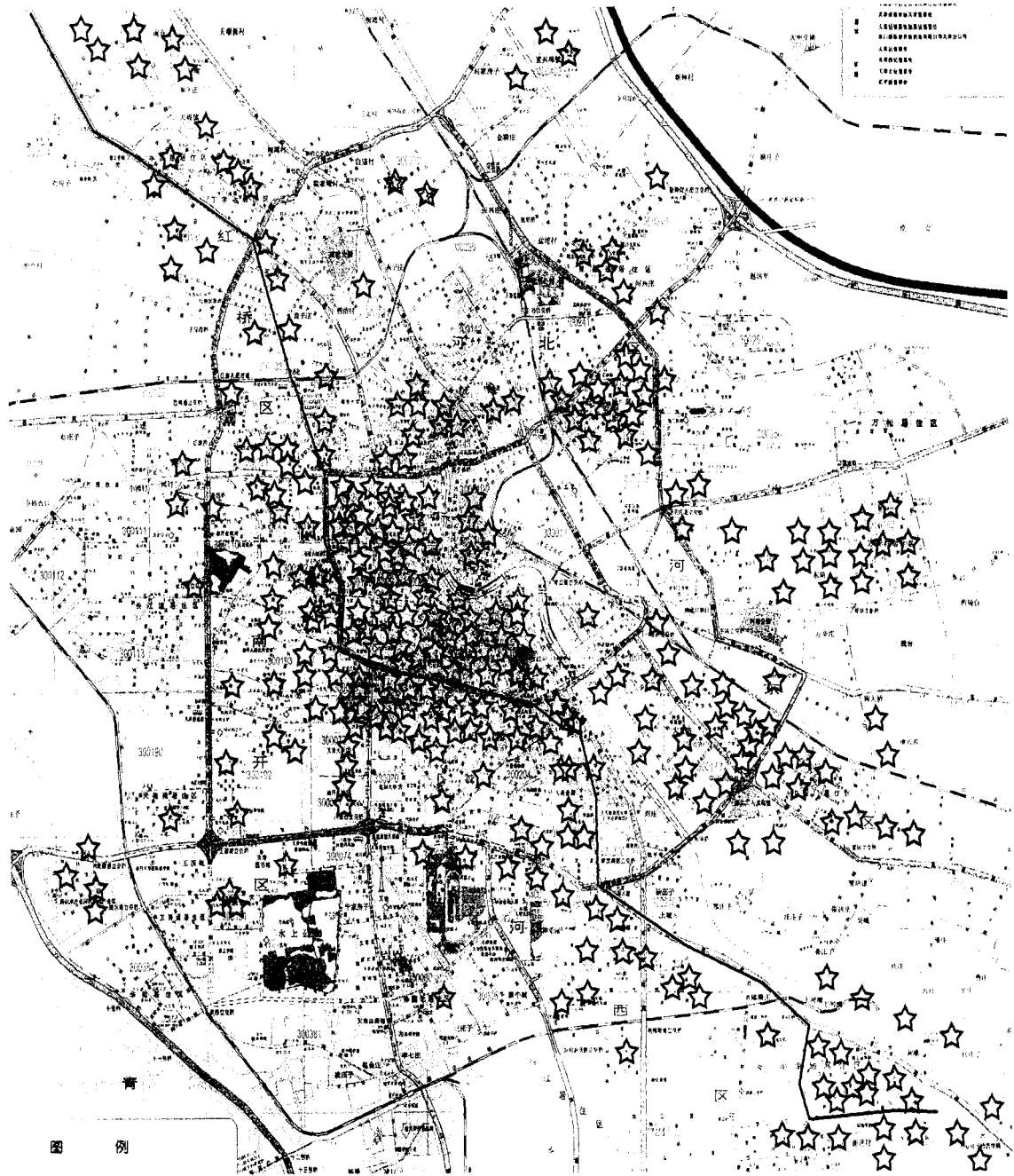


**Appendix C: Tianjin policemen take bicycles** Photo taken by author June 2005



**Appendix D: Traffic conflict - taxis, buses and bicycles** Photo taken by author June 2005





Appendix E: Map of Tianjin Metro system and interviewee's home location.

Legend:

Scale: 1:100000

\_\_\_\_\_ Metro line

★ interviewee's home location

调查问卷

NO.

日期 2014.5.5

地点

您好,我是天津大学规划系的学生,请您协助我们参与一项关于城市交通现状的调查,这将有利于交通的可持续发展,感谢您的支持,祝你幸福健康快乐.

1. 职业类别

- (1) 国有企业职工; (2) 社会服务行业; (3)  三资企业; (4) 行政机关; (5) 企业家;  
(6) 学生; (7) 离退休人员; (8) 其他;

2. 家庭成员数量: ( 5 ) 人

3 家庭生活月收入

- (1) <1,000¥ (2) 1,000-2,000¥ (3) 2,000-3,000¥ (4) 3,000-5,000¥  
(5) 5,000-10,000¥ (6) >10,000¥

4. 居住地址范围

靠近 \_\_\_\_\_ 路(街) 与 \_\_\_\_\_ 路(街) 交叉口

5. 家庭成员经常性选择的交通工具

- (1) 自行车 \_\_\_\_\_ 辆; (2) 轿车 \_\_\_\_\_ 辆; (3) 摩托车或助动车 \_\_\_\_\_ 辆;

6. 请列出前一天内所有从家出发的行程

请列出每一个距行目的地最近的交叉口,行程目的和方式.

目的: (1) 上班 (2) 休闲 (3) 购物 (4) 社交 (5) 其他

方式: (1) 步行 (2) 自行车 (3) 摩托车 (4) 小汽车 (5) 出租车  
(6) 公共汽车 (7) 电车 (8) 地铁

目的地(或路程链)	出行目的	出行方式	花费时间
天津大学	上班	步行	15分钟
天津大学	上班	步行	15分钟
天津大学	上班	步行	15分钟
天津大学	上班	步行	15分钟
天津大学	上班	步行	15分钟
天津大学	上班	步行	15分钟
天津大学	上班	步行	15分钟

7 对上表中的前三次出行可能采用的几种出行方式进行评价

	速度 (快,中,慢)	费用 (高,中,低)	舒适程度 (强,中,差)	灵活 (强,中,差)	准时 (是,否)	安全性 (强,中,差)
步行	中	低	强	中	是	强
自行车	中	低	强	中	是	强
摩托车	快	中	中	强	是	中
小汽车	快	高	中	强	是	中
出租车	快	高	中	强	是	中
公共汽车	中	低	中	中	是	中
电车	中	低	中	中	是	中
地铁	快	低	中	中	是	中

8 列出日常生活中围绕居住地址的出行方式

到达目的地	原因	方式	花费时间
天津大学	上班	步行	15分钟
天津大学	上班	步行	15分钟
天津大学	上班	步行	15分钟
天津大学	上班	步行	15分钟

什么因素让你选择乘坐地铁?

1. 方便 2. 快捷 3. 安全 4. 舒适 5. 准时 6. 费用低 7. 环保 8. 节省时间

Appendix F: Questionnaire